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Effect of Industrial Effluent on the Groundwater Quality in Haridwar

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Abstract
A study was conducted in Haridwar to evaluate the effect of industrial effluent on groundwater. A total number of seven water samples were considered, five samples were collected from State Industrial Development Corporation of Uttarakhand Limited (SIDCUL) and two ground water samples were collected from Salempur, a village situated nearby SIDCUL, Haridwar. Samples were analyzed for parameters such as pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Solids (TS), total hardness, electrical conductivity, salinity, Lead (Pb), Chromium (Cr), Arsenic (As), Iron (Fe), Aluminium (Al), Manganese (Mn) and Nickel (Ni). The results were compared with limits prescribed by Bureau of Indian Standards. It was observed that ground water near the industrial area has been polluted. It can be concluded from the study that waste water of industry is affecting the ground water quality and thus posing a major threat to health of the people living in Salempur.

Keywords- Industrial Effluents, Ground Water, Physicochemical Analysis, Heavy Metal Analysis and Heavy Metals Toxicity.

1. Introduction

Industrialization has been regarded as synonymous with economic growth and development. Rapid industrial growth witnessed by us in last two decades have been key to economic development of India. The strategic competitiveness and sustainability of our industrial growth story can only be maintained by ensuring best possible use of our human and physical resources (Jena and Mohanty, 2005; Poonkothai and Parvatham, 2005; Pawar et al., 2006; Mishra and Dinesh, 1991; Morrissette and Mavinic, 1978).

It's imperative that industries should be encouraged to become more efficient in terms of resource use and take all possible steps in minimizing adverse impacts on human health and environment. The waste water discharged from industries is severely harmful to the environment, surface water, ground water and soil (Ho et al., 2012; Adefemi, and Awokunmi, 2010; Agarwal and Saxena, 2011; Kataria et al., 1996; Ellis, 1989). The ground water has been used for drinking purpose for a long time; its purity has made it the main source of potable water in all over the world. Industrial effluents and ground water in the surrounding area of industries contains a higher amount of condiments with heavy metals. Heavy metals are usually present in small amount in natural water, but many of them are toxic at very low concentration though many of the metals are essential components of the biological system

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(Bharti et al., 2013; Adeyeye, 1994; Chavan et al., 2005; Hemkes et al., 1980; Jakkala and Ali, 2015). Metals like As, Pb, Ni, Hg, Cd, Zn, Cr, Co and Se are highly toxic even in minor quantity.

Industrial waste water released on the land as well as dumping into the surface water leaches into the ground water and leads to contamination due to the accumulation of toxic metallic components, thus creating challenges for human consumption because many contaminants cannot be completely degraded (Malarkodi et al., 2007; Ahmed and Krishnamurthy, 1990; DeGrandpre, 1993; Dickson and Goyet, 1994; Hopkinson, 1985). Ground water pollution has become more complex and critical not only in developing countries, but also in developed nations (Deepali and Joshi., 2012; Kumar and De, 2001; Kumar and Sinha, 2010; Manjare et al., 2010). The Haridwar district came into existence in 1998 as a separate district of Uttar Pradesh and it became one of the 13 districts of the newly created Uttarakhand state in the year 2000. Haridwar being the most important religious, cultural and spiritual center of the world is also the entry point to sacred Char Dham circuit located in Uttarakhand. Haridwar has a total area of 2360 sq. km and divided into 3 tehsils and 6 development blocks. Globally Haridwar is on latitude 29.58^0 N and longitude 78.13^0 E.

The study has been undertaken to evaluate and assess the quality of ground water of SIDCUL Haridwar and adjoining Salempur and effect of industrial effluents on it. In this study five industrial and two ground water samples were collected from SIDCUL, Haridwar. Samples were analyzed for various parameters like pH, TDS, TSS, TS, total hardness, electrical conductivity, salinity, Pb, Cr, As, Fe, Al, Mn and Ni. The industries located at SIDCUL, Haridwar have been responsible for contaminating the ground water due to the discharge of untreated effluents. The villagers of Salempur area are using water tanker for drinking purpose. Animals are dying because the stream water of Salempur is contaminated.

The objectives of this study was to investigate water quality of industrial effluent and groundwater of Salempur. The effect of industrial effluent on the groundwater was also assessed in this study.

2. Material and Method

2.1 Location of the Study

The study area as depicted in Figure 1 was conducted at SIDCUL and Salempur, Haridwar. SIDCUL, Haridwar is a very big industrial area in Uttarakhand that has about 600 – 700 companies in it. The industries that were considered for this study are emitting heavy metals and are polluting nearby surface water and ground water.

2.2 Sample Collection

The water samples were collected in the month of June 2015. The industrial waste water samples were collected from five industries A, B, C, D and E. Two ground water samples (F

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and G) were collected from Salempur village, Haridwar which is about 1 km away from industrial area.

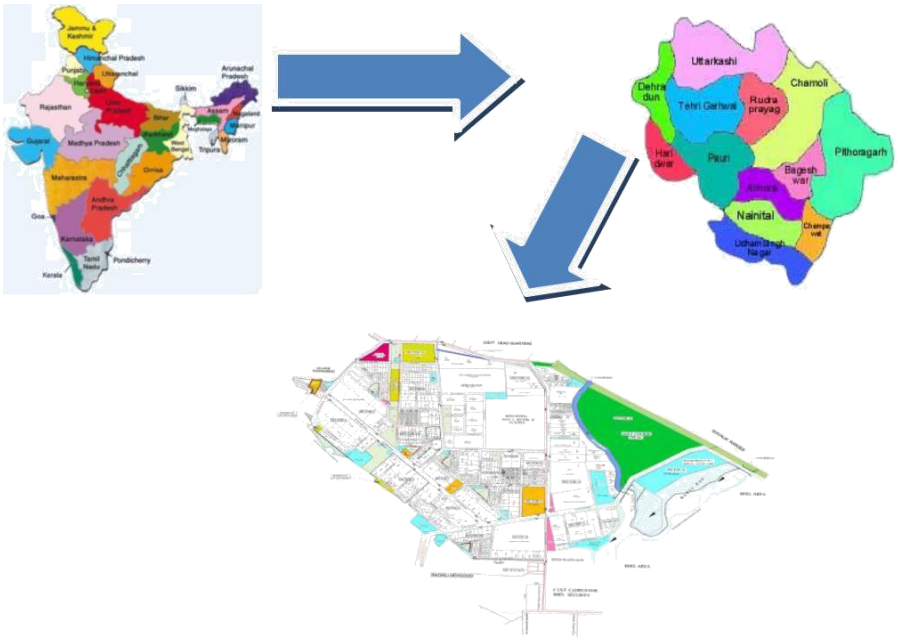

Figure 1. Study area SIDCUL, Haridwar

2.3 Sample Analysis

All the samples were analyzed according to the guidelines of American Public Health Association (APHA, 1999). The parameters that were analyzed are pH, TDS, TSS, TS, total hardness, electrical conductivity, salinity, lead, chromium, arsenic, manganese, iron, aluminum, and nickel. TDS, EC and salinity were determined with the help of the multi parameter system (HACH). The pH was analyzed with the help of a digital pH meter (SUNRISE) and the total hardness was determined by titration method using standard EDTA. The heavy metals Pb, Cr, As, Mg, Fe, Al, Mn and Ni were analyzed by inductively coupled plasma mass spectrometry (PerkinElmer SCIEX- ELAN DRC-e).

3. Results and Discussion

3.1 Physicochemical Analysis

On comparing the physicochemical parameters of all seven samples (Table 1), it has been observed that the pH value of industrial effluents and ground water has varied between 2.42 to 7.81. Sample A, B, C, E, F and G have pH ranging between 6.16 to 7.81 except sample D having pH 2.42. According to BIS sample D is not permissible for drinking purpose. The highest Electrical Conductivity was obtained for sample C (11.22 ms/cm) and sample G has the lowest conductivity value of 0.457 ms/cm. Rest five samples have shown conductivity

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between 0.631 – 5.91 ms/cm. TSS values were varied between 1 – 602 mg/l. Sample A has the highest TSS value and ground water samples F and G has lowest TSS value.
It has been found that the values of TDS in samples E, F and G were within the permissible limit for drinking water as suggested by BIS .The total dissolved solids in samples A, B, C and D was above the BIS permissible limit. Sample C was having highest TDS (6950 mg/l) and lowest was of sample G (280 mg/l). Total solids varied between 281 – 7035 mg/l. In all the samples, sample C has the highest TS value and ground water samples F and G was found to possess lowest TS value.

Maximum hardness was shown by Sample A whereas minimum hardness was found in sample D. Hardness of Sample A was above the permissible limit and samples B, C, D, E, F and G were under the permissible limit. The maximum salinity was obtained for ground water samples F and G as compared to samples from industries A, B, C, D, E.

3.2 Heavy Metal Analysis

The values of various heavy metals are tabulated in Table 2. The toxic level of lead in the human body is 500 ppm beyond which it causes anaemia, brain damage and vomiting, etc. The maximum permissible concentration of lead in drinking water is 0.01 ppm according to BIS (2012). Concentration of Lead for samples B, C, E, F and G samples was found to be within permissible limits, however sample A (0.031 mg/l) and D (1.174 mg/l) were above the permissible limit of BIS (2012).

According to BIS (2012) the permissible limit of Chromium in drinking water is 0.05 mg/. The values of the chromium content in all water samples were higher than maximum permissible level ranging between 0.064-0.138 mg/l. It was found that sample F has the maximum Chromium content and sample C has the lowest value of all the samples.

Arsenic is very toxic to human health (Rakib and Bhuiyan, 2014). Contamination by Arsenic in drinking water results in severe health problems such as skin problems, cancer of the lung, kidney and bladder (WHO, 1975).The maximum concentration of As in drinking water is 0.05 mg/L by BIS. It was found that concentration of all samples were between 0.001-0.007 mg/l and were within the BIS permissible limit. In all the samples, sample A has the highest value of arsenic and sample F shows the lowest value of arsenic.

Iron in excess amount causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness (Patil and Ahmed, 2011). It was found that the value of iron in all water samples was in between 0-0.044 mg/l and were under the permissible limit prescribed by BIS.

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Table 1. Physico chemical parameters of various samples with BIS permissible limit

Sample	pH	EC	TSS	TDS	TS	Total	Salinity
		(ms/cm)	(mg/l)	(mg/l)	(mg/l)	Hardness	(mg/l)
						(mg/l)	
A	6.22	5.91	602	3660	4262	630	3110
B	6.66	0.627	20	1004	1024	290	813
C	7.81	11.22	85	6950	7035	90	6130
D	2.42	5.87	16	3630	3646	51	3080
E	6.64	2.04	90	1245	1254	150	1026
F	6.20	0.631	1	388	389	280	307000
G	6.16	0.457	1	280	281	270	219000
BIS*(permissible limit) (2012)	6.5-8.5			2000		600	

Table 2. Concentration of heavy metals in samples with BIS permissible limit

Sample	Pb	Cr	As	Fe	Al	Mn	Ni
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
A	0.031	0.131	0.007	0	0	0.462	0.014
B	0.003	0.138	0.004	0.044	0	0.110	0.003
C	0	0.064	0.005	0.037	0	0.120	0.338
D	1.174	0.088	0.004	0	0	0.337	0.075
E	0.004	0.101	0.003	0	0	0.740	0.018
F	0.008	0.144	0.001	0	0.069	1.650	0
G	0.003	0.116	0.002	0	0.051	1.408	0.003
BIS* (permissible limit)	0.01	0.05	0.05	0.3	0.2	0.3	0.02

***Bureau of Indian Standard (2012)**

Aluminium causes neurological disorders in humans and its accumulation in the brain has been linked to various neurodegenerative diseases (Yokel, 2002; Zatta et al., 2003). Aluminum concentration in all the industrial samples and ground water samples was from 0 to 0.069 mg/l and was within the permissible limit. Ground water samples F and G have the maximum concentration of Aluminium.

Manganese is an essential element, which is used by plants and animals for their growth and maintenance (Kumar et al., 2015). Manganese is an essential micronutrient however its excess accumulation in humans results in neuronal disorders, bone diseases in babies, rheumatoid arthritis and diabetes etc. (Jumbe and Nandini, 2009). The concentration of Manganese in samples A, D, E, F, G were above permissible level. Sample F had highest (1.65 mg/l) and sample B had the lowest concentration (0.11 mg/l) of Manganese.

The main sources of Nickel pollution include industrial waste from nickel alloys or nickel compounds manufacturing plants, oil burning power plants, colour ceramic making plants, of batteries, etc. In humans Ni toxicity induces nausea, vomiting, abdominal pain and breath problems etc. (Sunderman et al., 1988). All samples except sample C and D had values below permissible limit. The concentration of Nickel in Sample C and D were 0.338 and 0.075 mg/l, respectively.

4. Conclusions

According to the above results and discussions it can be concluded that most of the parameters in ground water samples are within the permissible limit. However chromium and manganese in ground water samples from salempur has shown concentration higher than permissible level of BIS. Parameters like pH, total dissolved solids, salinity, lead, chromium, manganese and nickel of some industrial samples have shown values above the permissible level of BIS. However the presence of high concentration of chromium and manganese in ground water samples can be attributed to untretaed industrial effluents in this area. It is recommended that industrial effluents should be treated adequately and evaluated before discharging into surface water and ground water. Monitoring the health of villagers in Salempur and nearby area is highly recommended. If proper monitoring and remediation method are not taken in a time bound manner, it can result in serious threat to human health and animal population in the study area.

References

Adefemi, S. O., & Awokunmi, E. E. (2010). Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria. African Journal of Environmental Science and Technology, 4(3), 145-148.

Adeyeye, E. I. (1994). Determination of trace heavy metals in Illishaafricana fish and in associated water and soil sediments from some fish ponds. International Journal of Environmental Studies, 45(3-4), 231-238.

Agarwal, A., & Saxena, M. (2011). Assessment of pollution by physicochemical water parameters using regression analysis: a case study of Gagan river at Moradabad-India. Advances in Applied Science Research, 2(2), 185-189.

Ahmed, M., & Krishnamurthy, R. (1990). Hydrobiological studies of Wohar Reservoir Aurangabad (Maharashtra state) India. Journal of Environmental Biology, 11(3), 335-343.

APHA. (1999). Standard methods for the examination of water and wastewater, 19thEdn. Washington, D.C.

Bharti, P. K., Kumar, P., & Singh, V. (2013). Impact of industrial effluents on ground water and soil quality in the vicinity of industrial area of Panipat city, India. Journal of Applied and Natural Science, 5(1), 132-136.

BIS. (2012). Drinking Water - Specification (second revision of IS 10500).

Chavan, R. P., Lokhande, R. S., & Rajput, S. I. (2005). Monitoring of organic pollutants in Thane creek water. Nature Environment and Pollution Technology, 4(4), 633-636.

Deepali., & Joshi, N. (2012). Study of ground water quality in and around SIDCUL industrial area, Hardwar, Uttarakhand, India. Journal of Applied Technology in Environmental Sanitation, 2(2), 129-134.

DeGrandpre, M. D. (1993). Measurement of seawater pCO2 using a renewable-reagent fiber optic sensor with colorimetric detection. Analytical Chemistry, 65(4), 331-337.

Dickson, A. G., & Goyet, C. (1994). Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water. ORNL/CDIAC-74.

Ellis, K. V. (1989). Surface water pollution and its control, the Macmillan Press Ltd., Basingstoke and London, 373pp, hardback. isbn 0-333-42765-5 £60.

Hemkes, O. J., Kemp, A., & Van Broekhoven, L. W. (1980). Accumulation of heavy metals in the soil due to annual dressings with sewage sludge. Netherlands Journal of Agricultural Science, 28(4), 228-237.

Ho, Y. C., Show, K. Y., Guo, X. X., Norli, I., Abbas, F. A., & Morad, N. (2012). Industrial discharge and their effect to the environment, Industrial Waste, Prof. Kuan- Yeow Show Edn. ISBN; 978-953-51-0253-3, In Tech, 1-32.

Hopkinson, C. S. (1985). Shallow-water and pelagic metabolism: Evidence of heterotrophy in the near-shore Georgia Bight. Marine Biology, 87(1), 19-32.

Jakkala, L. K., & Ali, S. A. (2015). Amelioration of the toxic effects of aluminium induced neurodegenerative changes in brain of albino rats by aloe vera. Journal of Global Biosciences, 4(8), 3171-3177.

Jena, P. K., Mohanty, M. (2005). Processing of liquid effluents of mineral processing industries, Intl Symposium Environ Manag Mining Metallurgical Industries, 11-14 ,Bhubaneshwar, 193- 212.

Jumbe, A. S., & Nandini, N. (2009). Impact assessment of heavy metals pollution of Vartur lake, Bangalore., Journal of Applied and Natural Science, 1(1), 53-61.

Kataria, H. C., Quershi, H. A., Iqbal, S. A., & Shandilya, A. K. (1996).Assessment of water quality of Kolar reservoir in Bhopal (M. P.). Pollution Research, 15(2)**,** 191-193.

Kumar, A., & De, A. K. (2001). Environmental studies, New age International Publications, New Delhi.

Kumar, N., & Sinha, D. K. (2010). Drinking water quality management through correlation studies among various physicochemical parameters: A case study, International Journal of Environmental Sciences, 1(2), 253-259.

Kumar, S. M. G., Meera, D., & Sherly, P. A. (2015). Hydrological assessment of trace metal components from some lentic fresh water aquifers, south west coast of India. International Journal of Science and Research, 4(12), 316-321.

Malarkodi, M., Krishnasamy, R., Kumaraperumal, R., & Chitdeshwari, T. (2007). Characterization of heavy metal contaminated soils of Coimbatore district in Tamil Nadu. Journal of Agronomy, 6(1), 147-151.

Manjare, S. A., Vhanalakar, S. A., & Muley, D. V. (2010). Analysis of water quality using physico-chemical parameters Tamdalge tank in Kolhapur district, Maharashtra. International Journal of Advanced Biotechnology and Research, 1(2), 115-119.

Misra, S. G., & Dinesh, D. (1991). Soil Pollution, Ashing Publishing House, New Delhi, India.

Morrissette, D. G., & Mavinic, D. S. (1978). BOD test variables. Journal of the Environmental Engineering Division, 104(6), 1213-1222.

Patil, G., & Ahmed, I. (2011). Heavy metals contamination assesment of Kanhargaon Dam water near Chhindwara city. Acta Chimica and Pharmaceutica Indica, 1(1), 7-9.

Pawar, A. C., Kumar, N. J., Jadhav, N., Devi, V., & Pawar, S. C. (2006). Physico-chemical study of ground work samples from Nacharam Industrial area, Hyderabad, Andhra Pradesh. Journal of Aquatic Biology, 21(1), 118-120.

Poonkothai, M., & Parvatham, R. (2005). Bio-physico and chemical assessment of automobile wastewater. Journal of Industrial Pollution Control, 21(2), 377-380.

Rakib, M. A., & Bhuiyan, M. A. H. (2014). Arsenic contamination: Food toxicity and local perception. International Journal of Scientific Research in Environmental Sciences, 2(1), 1-7.

Sunderman, F. W., Dingle, B., Hopfer, S. M., & Swift, T. (1988). Acute nickel toxicity in electroplating workers who accidently ingested a solution of nickel sulfate and nickel chloride. American Journal of Industrial Medicine, 14(3), 257-266.

WHO. (1975). International standard of drinking water. Geneva, WHO.

Yokel, R. A. (2002). Aluminium chelation principles and recent advances. Coordination Chemistry Reviews, 228(2), 97-113.

Zatta, P., Lucchini, R., van Rensburg, S. J., & Taylor, A. (2003). The role of metals in neurodegenerative processes: aluminum, manganese, and zinc. Brain Research Bulletin, 62(1), 15-28.